1986 DROUGHT IN THE SOUTHEAST UNITED STATES

HEARING

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STATEMENT OF THOMAS R. KARL, NATIONAL CLIMATIC CENTER, ASHEVILLE, NC

Mr. KARL. First off, I would like to thank the committee for inviting me today to put the drought in the Southeast in some kind of historical perspective. In order to do that, I think there are two things we have to keep in mind when we talk about drought.

There is a drought that can affect the agricultural community, which we may refer to as an agricultural drought, and then there is another kind of a drought, a longer term drought that I will refer to as kind of a hydrological drought that would be related to the conditions that would be reflected in streams, lakes, and reservoirs.

If we take a look at the drought in those two areas, one of the things that is clear is that in terms of the hydrological droughts, let me summarize in terms of climatological characteristics. It was an unusual event. You can look at the hydrological perspectives of the droughts a number of different ways, and depending on how you look at it, you come up with recurrence intervals—that is how likely would a similar kind of drought like this be likely to occur in some of the areas in North Carolina, in Georgia, South Carolina, how likely would they occur in the future, given there was no change in climate.

Depending how you look at the situation, you can come up with recurrence intervals between 20 and 60 years for long, cumulative departures from normal in terms of precipitation or you can get

return periods of the order of a couple hundred years if you look at in terms of the intensity of the current drought we just had.

If you take a look at the drought in terms of the agricultural characteristics, it truly was a remarkable event. If you look at the growing season departures of moisture anomalies, from March through July, it truly is an unprecedented event.

We get recurrence intervals of several hundred years in some of the most severely impacted areas of North Carolina. So one of the questions that immediately one raises when you get these kinds of rare events—and I might mention that rare events sometimes do occur without any changes in climate—but one of the questions that you frequently run across is, does this portend a real change in climate?

Is there something different now that is going on that has not gone on in the past?

In order to do that, one of the things I would just like to remind everyone here of is we did have a very serious drought in our country in the 1930's related to the Dust Bowl days. If we take a look at some of the conditions in that part of the country, look at it in the same way we have looked at the drought in North Carolina, we find that in those areas during that very dry period recurrence intervals much the same as what we are finding in North Carolina, in fact, in some instances even longer.

Yet, if you look at those areas right now they are coping with too much rain. Lakes in many areas of the Midwest and Western part of the country are exceeding their banks, Great Salt Lake and Great Lakes to name a few.

So I think we have to realize that what is ongoing right now is part of what climatologists may call a climate fluctuation. That is, if we look at the past climate record, we find periods, 10-, 20-, 30-year long periods where the climate seems to shift to a different regime. We are not exactly sure why these shifts occur.

We can explain them in terms of changing jet stream patterns and sea surface temperatures and tropical storm activity and that kind of thing, but the real question is just why does the climate reach this kind of equilibrium over these long periods.

What particularly makes the drought in the Southeast noteworthy is that we have just come off of a period in the late fifties, sixties, and up through the late seventies, of very ample moisture throughout the Southeast, more than we have had in the past 100 years. So we were indeed fixed in a 20-, 30-year climate fluctuation where we were used to more rainfall that we have had in the last few years.

Again, I might mention if you remember, we had a drought in 1980, 1981 in the Southeast and the current drought really had some break in it last fall due to some tropical storm activity, but things were dry down here even in 1984 and parts of 1985 before the recent 1986 dry conditions.

So in total, I think the big question is just what is causing these climate fluctuations. The answer to that is we are not exactly certain, however, there is no evidence to suggest that these fluctuations are caused by anything that man is doing right now, for example, the carbon dioxide greenhouse gas phenomenon.

We do have evidence, however, in the past that these kinds of things do occur and have occurred and I think one of the primary responsibilities we need to look at now is exactly why these long-term fluctuations are occurring in the climate record.

This is a little bit different emphasis than, for instance, looking at next month's weather. We are talking about a much longer time scale. Let me just summarize here some of the important points.

First off, the drought in terms of an agricultural perspective in the Southeast was, indeed, the most severe that we have witnessed in the past century and its recurrence interval without climate change is in the order of a couple hundred years.

The hydrological drought which affects stream flows and lakes, which has resulted in some of the lowest stream flow in more than half a century, is unusually severe, but to date it is not unprecedented in terms of its duration, and in fact, is still ongoing.

We are not out of the woods yet, so to speak.

Finally, there is no evidence to indicate that the 1986 drought is a result of increasing carbon dioxide or other trace gases. Rather, it appears the most recent drought is part of one of a series of climate fluctuations that are typical of the climate record not only in this area, but throughout much of the United States and the globe.

That is all I have to say.

[The prepared statement of Mr. Karl follows:]

Testimony of

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on

The 1986 Southeast Drought in Historical Perspective

for the

Subcommittee on Natural Resources, Agricultural Research, and Environment

Committee on Science and Technology

United States House of Representatives

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I am pleased to be able to provide this subcommittee with a historical perspective of the 1986 drought in the Southeast. In order to facilitate the subsequent testimony it is important that we understand what is meant by the word "drought." The word itself often has different meanings to various groups depending upon their specific interests. Today, I will refer to two aspects of drought. The first aspect will pertain to the hydrological drought or the long-term water deficiency in deep soil profiles. This aspect of drought is important with respect to regional, municipal, and local water supplies used for domestic, commercial, and industrial processes. The hydrological drought usually requires at least several months of dry weather to develop. Likewise, it normally takes an extended period of wetness, months to years, before the hydrological drought ends; returning water levels in streams, lakes, and ground water to near normal.

The second aspect of drought that I will address pertains to a short-term moisture deficiency in shallow plant root zones or the so-called "agricultural drought." By definition, this occurs whenever the vegetation of an area is stressed due to an inadequate or below normal supply of moisture. This type of drought can develop rather suddenly compared to the hydrological drought. Sometimes just a few weeks without adequate moisture in the Southeast, depending on the timing during the growing season, can often lead to reduced crop yields and stress on vegetation.

It is important to understand that the hydrological drought may persist during several waxings and wanings of the agricultural drought. Likewise, the onset and termination of an agricultural drought can occur in the midst of a hydrological wet spell.

Two further clarifications are required. I will discuss the 1986 Southeast Drought from a climatological perspective. Note that for equal anomalies of dry weather separated in time, the human impact of these events may not necessarily be the same. Changes in water demand, i.e., increased usage for industrial, commercial, or domestic purposes, or changes in water supply and distribution, i.e., new reservoirs, loses in water supply lines, new water supply lines, etc., are not accounted for in a climatological perspective. Additionally, it must be recognized that drought is relative to some expected normal. For example, our natural environment and our local economies in the Southeast are based on a relatively ample supply of rainfall compared to drier portions of our nation such as the western Great Plains or the Southwest. Using this concept of drought, the departure from the expected moisture supply is "all important," rather than the absolute amount of precipitation, in order to compare and contrast the temporal and spatial characteristics of droughts.

<u>The initiation and development of the 1986 drought</u>.

During the fall of 1985, largely due to a very wet October and November, much of the Southeast United States was able to pull itself out of the hydrological drought that had developed over the

area during the past year. This included the Carolinas (NC and SC), the Virginias (VA and WV), Georgia (GA), parts of Alabama (AL), and Florida (FL), as well as the eastern half of Tennessee (TN). During the subsequent winter months, December 1985 through February 1986, a lack of Gulf Coast and East Coast winter storms resulted in the driest winter of the twentieth century in NC, the second driest in Mississippi (MS), Louisiana (LA), and TN, and the fifth, sixth, and seventh driest winters in SC, AL, and Kentucky (KY) respectively. As a result, by the end of winter a moderate hydrological drought had re-developed from LA northeast to southern VA. Conditions continued to deteriorate during the beginning of the growing season in the Southeast. March through May was the second driest spring of the twentieth century in NC, the third driest in TN and VA, the sixth driest in KY, and the eighth driest in SC. These conditions intensified the hydrological drought leading to a simultaneous occurrence of a severe agricultural drought in many of these states. Precipitation continued to be well below normal across AL, SC, NC, VA, and GA during the first two months of summer as the driest June of the twentieth century was recorded across the state of VA, and the seventh driest in NC, SC, and GA. Temperatures during these months were much above normal, increasing the demand for water. The warmest July of the twentieth century was recorded in the states of NC, SC, and GA while TN, VA, and AL had their sixth or seventh warmest July. Precipitation remained well below normal during July in all of these states with SC and GA having their third and fourth driest Julys. The dry and hot weather produced the most extreme agricultural drought of record in many of these areas. The hydrological drought continued to worsen through July when it reached its maximum areal extent. Streamflow across most of the southeast was less than 50% of normal during these months. During August and September cooler and wetter conditions abated the agricultural drought in most areas of the Southeast and improved, but did not end the hydrological drought.

The 1986 hydrological drought in historical perspective.

In order to make some quantitative inferences regarding the severity of the hydrological drought a model has been developed which produces an index of hydrologic drought severity. This index, the Palmer Hydrological Drought Index, identifies the month of drought initiation as well as termination. During each drought episode precipitation deficiencies can also be calculated in terms of accumulated precipitation deficits from normal. In order to put the current drought in perspective, we have used the model to evaluate the climatological data throughout the United States back to the turn of the century. This has been completed for nine of the most severely affected areas of the Southeast ---

1) North Central, GA,
2) Northeast, GA,
3) Central, GA,
4) Southern Mountains, NC,
5) Northern Mountains, NC,

6) Central Piedmont, NC,
7) Southern Piedmont, NC,
8) Northwest, SC, and
9) Eastern, TN.

Using a statistical model it is possible to estimate the unusualness of the recent hydrological drought. Using the actual index of the hydrological drought severity as a measure of its intensity the results indicate that on average, assuming no climate change, we can expect a hydrological drought as severe as the 1986 drought to recur about once in every 40 to 100 years for the areas outside of NC, and in excess of 100 years for the regions tested within NC. On the other hand, using the cumulative deficit of precipitation as a measure of drought severity the recurrence intervals for a hydrological drought as severe as the 1986 drought are between 20 and 60 years. The exact year varies with each region. Additionally, at least half of the streams in the area set new record low streamflows by the end of July. These streams had records dating back from 48 to 91 years.

By way of comparison, one of the most severe hydrological droughts in the United States occurred during the dust bowl days of the 1930s in West Central, Minnesota (MN). For that particular hydrological drought the recurrence interval is about once in every 200 to 400 years regardless how it is viewed.

We must recognize however, the final word may not have been spoken regarding the ongoing hydrological drought in the Southeast. Despite the improved situation in most of the Southeast in recent months the hydrological drought index indicates that the 1986 drought, in hydrological terms, is not yet history. Indeed, its duration has been relatively short compared to the longer droughts in the climate record i.e., the 5-year long drought in the mid 1950s and others that have persisted for a couple of years.

The 1986 agricultural drought in historical perspective.

In order to estimate the severity of the climate conditions with respect to the agricultural drought in the Southeast another index is used, the moisture anomaly index. This index is a measure of the short-term moisture deficiency. It is evaluated on a monthly basis and has no memory of past conditions except for the initial amount of moisture in the soil at the start of a month. For each month of the year the index integrates several climate dependent variables. This includes the expected initial amount of moisture stored in the soil at the start of a month, the expected amount of rainfall runoff and recharge to the soil given the initial condition, and the expected amount of moisture to be given up by the soil due to evaporation and plant transpiration. The moisture anomaly index, or the Z-index as it is commonly called, has been calculated for the United States back to the turn of the century. The mean value of this index through the beginning and middle portions of the growing season (March through

July) was calculated for the nine regions most severely affected by the hydrological drought. By comparing the magnitude of the most recent drought with previous agricultural droughts for the same time period (March through July) it is possible to estimate the recurrence interval of the agricultural drought for each region.

Through the use of another statistical model the results indicate that for the areas in Georgia, an agricultural drought as severe as the recent one would not be expected to recur on average more than once in 100 years. For the other regions the recurrence interval is even longer. The average recurrence interval for an agricultural drought as severe as the recent drought in Eastern TN, Northwest SC, and the Southern Mountains of NC is about once in every 200 years. For the Central and Southern Piedmont and Northern Mountainous areas of NC the recurrence interval of the March through July agricultural drought is on the order of once in every several hundred years. The agricultural drought in these areas was the worst since climatological observations became routinely available (Circa 1890) and is truly remarkable in its strength.

Is the recent drought related to the predicted climate changes from increased carbon dioxide and other greenhouse gases?

We currently have no evidence to indicate that the recent drought is a result of global increases of carbon dioxide and other greenhouse gases. Assuming continued improvement of the hydrological drought the recurrence interval for the recent hydrological drought is not sufficiently long to make it inconsistent with the twentieth century climate record. The agricultural drought during the growing season (March through July) was quite remarkable in its intensity for a few selected areas, but single growing season events, even moderately rare ones, do not necessarily imply a semi-permanent change to a new climate regime.

The climate must be viewed on larger time scales. In this regard the most unusual characteristic of the precipitation climatology in the Southeast during the recent century has been the anomalously wet and cool years of the late 1950s and the decades of the 1960s and 1970s. This wet period coincided to some extent with the greatest change in our national average precipitation since the dust bowl days of the 1930s. Since 1970 spring and autumn precipitation across the nation as a whole has increased by about 6% and 12% respectively, compared to the twentieth century average. This has lead to nearly a 5% increase in annual precipitation. By comparison, on an annual basis the decade of the 1930s in the United States had almost 6% less precipitation than the rest of the twentieth century; yet, areas such as West Central MN, which were so severely affected by that drought, are now coping with too much water as many lakes in the United States, the Great Lakes and the Great Salt Lake to name just a few, are at record high levels.

As more and more of the twentieth century climate records are compiled and processed the evidence seems to indicate that our climate is dynamic not static. Until we can adequately explain many of these decadal climate fluctuations it will be difficult to unequivocably relate ongoing climate anomalies such as the recent drought in the Southeast to increases in greenhouse gases.

Summary

1. The 1986 agricultural drought in the Southeast during the critical March through July period, was the most severe that we have witnessed in the past 90 years.

2. The hydrological drought, which resulted in the lowest observed streamflows in more than half a century, is unusually severe, but, to date, not unprecedented in terms of duration and has not ended.

3. There is no evidence that the 1986 drought in the Southeast is a result of increasing carbon dioxide or other trace gases. Rather, it appears that the most recent drought is part of another one of a series of climate fluctuations that are typical of the climate record of the United States throughout the twentieth century.

Mr. VALENTINE. Thank you very much, Mr. Karl.

Briefly, could you just describe your operation?

What is the National Climatic Center?

How many people are involved and what do you do? What technologies do you employ?

Mr. KARL. One of our primary purposes is to collect data throughout the globe and archive it for climatological information for weather forecasting purposes, for in all countless kinds of studies that are needed in terms of being able to withstand environmental conditions.

We have about 300 employees, of which I guess about 120 of them right now are being contracted out—this very week, in fact. So I guess we are down to about 200-some-odd employees which collect data, gather it, summarize it, provide enough information to adequately describe the climate of the United States.

Mr. VALENTINE. Thank you, sir.

Mr. Cobey, any questions for this witness?

Mr. COBEY. Just one. You say there is nothing man has done to bring about this type of drought or the severity of it?

Mr. KARL. I say there is no evidence to suggest that this particular drought would be a result of anything man has done.

Mr. COBEY. This is a very simple question, but we continue to impound more and more water around the world. Does that have any impact on rainfall?

Mr. KARL. Certainly it has an impact, but the question is whether that impact is so minimal as to not be detectable. We have a number of environmental kinds of studies that have been done.

We know, for instance, impoundment of water affects the duration and frequency of fog, but very, very few instances to show the impoundment of water has actually changed the amount of precipitation that has occurred.

You may find some very, very few pieces of information where you could find some cloud trails, cloud streaks from impoundments of water, but it is few and far between.

Mr. COBEY. That is all I have.

Mr. VALENTINE. Mr. Chairman.

Mr. SCHEUER. Yes; how long do you think it is going to be, Mr. Karl, before we are going to be able to predict this drought or droughts like these well in advance?

Mr. KARL. I think we are decades away from predicting a drought such as this, primarily because it is an unprecedented event in many respects and in terms of predicting unprecedented events, that is one of the most difficult things one can be asked to do.

So I think for droughts as this one, I think we are a ways away. We may not be so far away of giving 3, 6 months notice that conditions may be below normal.

For instance, we may expect less precipitation than normal but that does not imply scope or magnitude of current situation.

Mr. SCHEUER. You call this an unprecedented event. Are unprecedented events like this and the 1977, 1978 severe cold, are they becoming less unprecedented?

In other words, are they becoming more frequent, and if so, why?

Mr. KARL. One of the things that becomes apparent when you look at the climate record, depending on what quantities you look at, for example, if you look at wintertime temperature and precipitation, for instance, the 1977, 1978 events, you find in the United States as a whole there is strong evidence to suggest that the climate is becoming more variable. That is, wintertime conditions across the whole United States.

One thing to keep in mind, and what is even more unusual, is the lack of this high variability we experienced in the sixties, early part of the seventies, and later part of the fifties.

So we had gotten use to, so to speak, a 25-year period in one of these climate fluctuations we are talking about, of unusually good weather.

So that puts the more recent change to more variable conditions in better perspective, that perhaps we weren't within our lifetime—we hadn't witnessed many of these unusual events we are now experiencing.

Mr. SCHEUER. Do droughts like this, massive acts, as you say, almost unprecedented droughts, do they have a tendency to reappear the following year?

In other words, is this a multiyear cyclical event that we can look forward to?

Mr. KARL. Yes; there have been a number of studies looking at cycles of drought and to date none of the studies indicate that there is any reasonable way of being able to predict the drought saying next year or the following year is more likely to have a drought.

Mr. SCHEUER. On a scale of 1 to 10, what would the predictability of another year's drought be? Would it be more than five or less than five?

Mr. KARL. For next year?

Mr. SCHEUER. For next year.

This is the severest drought we have had in the century, so you would think the chances for another year like this would be 1 in 100. Are they much more than that and if they are, is there anything we can do to ameliorate the possible devastating effects of this drought that we have a statistically higher than likely possibility that we have of suffering another one next year?

Mr. KARL. I would point out that since, if you look at the climate record, you find that we apparently in the Southeast now are in a different climate regime than we were in the fifties and sixties, that is, conditions are drier.

But I would also point out since we don't know why we are in this regime, conditions could change rather dramatically and quite fast. So, given the fact that we remain in the current regime, then the likelihood of a kind of a drought that we just had this past year would be higher than it might be otherwise.

But since we don't know exactly why we are in the climate regime we are now, things could just as rapidly change back to some new state and the problem is solved.

It is a basic problem in our not understanding the climate system in terms of being able to predict the drought.

Mr. SCHEUER. I thank the witness for his excellent testimony.

Mr. VALENTINE. Mr. Karl, before we dismiss you, let me say one more thing. You are not saying that we are in technology and our ability to look into the future and to predict a drought, you are not saying the best thing we have is the Farmers Almanac, are you? Never mind.

Mr. KARL. No. I am not saying the Farmers Almanac is the best thing. I am saying what we need to do is take a little bit closer look at these climate fluctuations and try to understand them with a little more detail.

Mr. SCHEUER. If it isn't the Farmers Almanac, is it the groundhog?

Mr. VALENTINE. Do you ever take a peek at one of these almanacs?

Thank you very much for coming. Your testimony has been very helpful.

Thank you.

Mr. KARL. Thank you, sir.

Mr. VALENTINE. The next panel is Gregory B. Fishel, WRAL, Raleigh; Chris Thompson, WPTF, Raleigh; Gregory Johnson and Katharine Perry from North Carolina State University.

STATEMENTS OF GREGORY B. FISHEL, WRAL, RALEIGH; GREGORY JOHNSON AND KATHARINE PERRY FROM NORTH CAROLINA STATE UNIVERSITY

Mr. FISHEL. As everybody has stated, I would like to thank the committee for the opportunity to speak and, I think, also to add to that a thanks not only for the opportunity to speak, but for the opportunity to learn, particularly from the first panel this morning.

Certainly in my business you can stand up and say that you can try to identify with what someone is going through, but until you have experienced that first hand or talked to someone who has, I don't think it affords itself a true meaning.

Here this morning we are talking about a drought which has already been discussed in an agricultural sense the worst of the century, in a hydrological sense, the worst of the half century.

Every time a catastrophe of this nature occurs two questions arise: No. 1, could we have dealt with the situation any more effectively making use of available information and technology; and two, what positive changes can be made to help avert a rerun of the summer of 1986.

This morning, I will discuss data which is currently available, both in terms of drought assessment, as well as forecasts of the future weather, then speculate as to how all this might be improved in subsequent years.

The Climate Analysis Center, contained within the National Meteorological Center in Washington, DC, disseminates drought information on a weekly basis in two forms. They are the Crop Moisture Index and the Palmer Index.

The Crop Moisture Index relates more to agriculture than anything else. It is used to estimate the amount of soil moisture available in a 5-foot profile, and then compares that with the need of warm season crops. The index responds rapidly to changes in soil